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ABSTRACT

Because of its bases in science and stewardship, aquatic resource education may be seen as a type of environmental education. The range of environmental education (EE) programs includes a huge variety designed for different groups and settings. This chapter takes the perspective of environmental education as it is done in the formal K-12 classroom situation, that is, with intact groups of individuals who are fairly homogeneous in terms of age and experience and have been assembled for the purpose of learning. Within that classroom the educational experiences are constrained by an existing system of practice and by methods of teacher preparation, both ingrained over many decades. What is acceptable to the classroom education system is structured by community mores and often supported inequitably across geographic regions. Change in classroom education comes at a glacial pace, and it is nearly always top-down and assessment-driven. By its definition, environmental education fosters the development of ecological knowledge, awareness of issues and how to solve them, and motivation to work toward environmental quality. A major goal is to build within learners and intention to act, which is seen as the most dependable precursor to environmentally responsible behavior. Unfortunately, traditional classroom curricula do not encourage, and community mores sometimes do not permit, the kinds of behavioral goals that are key to EE. According to theory and practice, environmental education topics that are appropriate to the curriculum can be infused in the existing curriculum if they are acceptable to teachers. New curriculum restructure in science and geography may offer some opportunities for aquatic resource education. The best EE is interdisciplinary, uses strong science, is implemented using active, cooperative learning, and is extended through service learning or filed activities. Getting aquatic resource education into schools through EE can be accomplished by meeting teachers' needs for topic, having excellent curriculum materials, and delivering them through a strong program of teacher education. (Contains 46 references.) (Author/YDS)

The Right Tools for the Job: How Can Aquatic Resource Education Succeed in the Classroom?

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Abstract – Because of its bases in science and stewardship, aquatic resource education may be seen as a type of environmental education. The range of environmental education (EE) programs includes a huge variety designed for different groups and settings. This chapter takes the perspective of environmental education as it is done in the formal K-12 classroom situation, that is, with intact groups of individuals who are fairly homogeneous in terms of age and experience and have been assembled for the purpose of learning. Within that classroom the educational experiences are constrained by an existing system of practice and by methods of teacher preparation, both ingrained over many decades. What is acceptable to the classroom education system is structured by community mores and often supported inequitably across geographic regions. Change in classroom education comes at a glacial pace, and it is nearly always top-down and assessment-driven.

By its definition, environmental education fosters the development of ecological knowledge, awareness of issues and how to solve them, and motivation to work toward environmental quality. A major goal is to build within learners and intention to act, which is seen as the most dependable precursor to environmentally responsible behavior. Unfortunately, traditional classroom curricula do not encourage, and community mores sometimes do not permit, the kinds of behavioral goals that are key to EE. According to theory and practice, environmental education topics that are appropriate to the curriculum can be infused in the existing curriculum if they are acceptable to teachers. New curriculum restructure in science and geography may offer some opportunities for aquatic resource education. The best EE is interdisciplinary, uses strong science, is implemented using active, cooperative learning, and is extended through service learning or field activities. Getting aquatic resource education into schools through EE can be accomplished by meeting teachers' needs for topics, having excellent curriculum materials, and delivering them through a strong program of teacher education.

Introduction

Environmental education (EE) programs are designed for many groups in many settings. This manuscript is written from the perspective of environmental education as it is done in the formal K-12 classroom situation, that is, with intact groups of individuals who are fairly homogeneous in terms of age and experience and have been assembled for the purpose of learning. It is the classroom environment and its potential with which the author is most familiar, having taught science in middle schools for seven years and designed teacher education programs in EE for nearly 25 years.

My understanding of the components of aquatic resource education (ARE) has them grouped into three sets:

- How to do aquatic activities (skills, rules, safety, etc., primarily for recreation)
- Why it works (ARE based on knowledge of resources and basics of systems/processes at work)
- How to keep it coming (stewardship for sustainability).

There are opportunities in formal EE to address many aspects of ARE, but not all of them are appropriate for this medium. In this manuscript I will describe school situations amenable to ARE and describe research that can support working within classroom systems in appropriate and effective ways.

Does it fit?

The title of this manuscript was at first, "Does boating, fishing and stewardship fit the classroom curriculum." The answer to that question would have to be "No, but..." The "No" part helps to explain why the question had to be changed: if the job is defined so narrowly, the classroom is the wrong place for it to be done. First, the traditional classroom curriculum, still followed in over 90% of schools despite national calls for reform in key subject areas, requires teachers to be accountable for a given body of prescribed information in a finite time period. That information is usually presented from a textbook, to pupils seated indoors, and assessed by competitive testing systems. Being on the test determines the relevance of the subject matter. Second, teachers have been prepared either in a specific discipline that defines their comfort zone for in-

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struction, or in the case of elementary teachers, in the range of subjects that young students must learn. Both the depth of secondary school disciplines and the urgency of the elementary curriculum are effective deterrents to inclusion of boating, fishing, and stewardship in schools. The "how-to" subject matter of boating and fishing just does not fit in any but the rare Physical Education programs of recreation education.

Stewardship education creates other issues for schools because it represents a value system. In some periods of school curriculum history, a humanistic approach has been acceptable and could include values clarification. In today's society, vocal parents or community groups may openly oppose school programs that appear to teach children what to believe (for example, the Center for Environmental Education Research, a project of the Competitive Enterprise Institute, provides anti-EE information for parents). Notwithstanding that the school programs make concerted attempts to portray their stewardship programs as community education, conservative groups can gather media attention to their protests and effectively stifle well-meaning efforts. A teacher in my city was threatened with a lawsuit because he invited students to help collect waste oil products on a weekend for recycling. Though participation was voluntary, this was seen as imposing his environmental values on the students.

Finally, to have boating and fishing how-to instruction would require some hands-on outdoor experience, but many schools are unable to take field trips and most do not have facilities nearby for such instruction. Field trips are stifled by rules against taking school buses beyond county lines in some districts, and by prohibition on private drivers in others. This assumes, of course, that there are qualified instructors, and that other teachers are willing to excuse students from classes they would miss during a field experience that might appear to be primarily recreation instead of school. Under the set of conditions outlined here, then, "No" is a defensible answer for many educators.

Does the chapter end here?

The rest of the answer to that original question (No, but...) is the one that would allow the possibility for inclusion of some aspects of ARE in schools. Curriculum restructure in science, geography, mathematics and other subject areas has broadened the scope of what can be sanctioned as school subject matter in those disciplines (still no how-to). Specific examples from national standards for these subjects offer some of the opportunities, based on "why it works" components of ARE.

Figure 1 – Science in personal and social perspectives

Levels K-4	Levels 5-8	Levels 9-12
Personal health	Personal health	Personal and community health
Characteristics and changes in populations	Populations, resources, and environments	Population growth
Types of resources	Natural hazards	Natural resources
Changes in environments	Risks and benefits	Environmental quality
Science and technology in local challenges	Science and technology in society	Natural and human-induced hazards
		Science and technology in local, national, and global challenges

Source: National Science Educations Standards 1996.

National Science Education Standards (NRC, 1996) were designed to make science relevant to students, thus some of the physics of sailing, the human impacts of water uses, trophic relationships of fish, and the biology and chemistry of water quality can easily be included in the content of instruction. Stewardship aspects still require caution, but can be approached through historic human impacts and data analysis for decision-making, through the Standards on Science in Personal and Social Perspectives. This set of standards includes the topics in Figure 1. Another science curriculum reform movement, represented by the *Benchmarks for Science Literacy* (AAAS, 1993), is used less than NSES because of an unwieldy format, but can still legitimize ARE in some areas of science instruction. Benchmark examples include:

- The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials. Human activities and technology can change the flow... [Flow of Matter and Energy, Grades 9-12.]
- Individual organisms with certain traits are more likely than others to survive and have offspring. Changes in environmental conditions can affect the survival of individual organisms and entire species. [Evolution of Life, Grades 5-8]

Framework of Understandings for Earth Systems Education

1. Earth is unique, a planet of rare beauty and great value.
2. Human activities, collective and individual, conscious and inadvertent, affect Earth systems.
3. The development of scientific thinking and technology increases our ability to understand and utilize Earth and space.
4. The Earth system is composed of the interacting subsystems of water, land, ice, air and life.
5. Earth is more than 4 billion years old, and its subsystems are continually evolving.
6. Earth is a small subsystem of a Solar system within the vast and ancient universe.
7. There are many people with careers and interests that involve study of Earth's origin, processes, and evolution.

A third curriculum restructure program for science is the grassroots, teacher-focused Earth Systems Education (Mayer and Fortner, 1995). ESE is a way of looking at the science curriculum with a focus on planet Earth, with its inherent wonders and local relevance to students. Based on a framework of seven Understandings, ESE describes the desirable outcomes of science education K-16 as identified by a group of leading teachers, science educators and scientists:

Clearly, stewardship (Understanding #2) has a high priority for science education about the Earth System. Indeed, in its higher education programs for Earth System *Science* Education the National Aeronautics and Space Adminisrration (NASA) places great emphasis on use of its space missions to learn about global environmental issues on Earth (Earth System Science, 1986). ESE is now being adapted in many forms in over 20 countries as science educators come to see its inherent value for today's science and Earth's future. Water, as one of the basic Earth subsystems, is a primary subject area and the topic of many curriculum innovations within ESE. [Best practice in instructional methods will be discussed in a later section.]

Geography is another subject area in which national standards hold opportunities for ARE (Downs, 1994). Of 18 Standards, those related to Environment and Society (# 16-18) are most easily identifiable with ARE, but the Box above demonstrates how a workshop on Aquatic Nuisance Species would use some other standards in teacher education.

It is also possible to use aquatic resources in the teaching of other subject areas as well, but in all cases, the resource in its recreational context is not the curriculum subject, just the vehicle through which the subject is taught. Some examples could include distant-rate-time problems using boat races or approaching storms, matching artificial lures to natural insects, or choosing lures that mimic natural prey of the desired fish.

Components of Environmental Education

Dr. William Stapp was the first to concisely define environmental education (1969):

> "Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution."

Thus, if we are looking for "what works," we need to consult the EE literature for indicators of quality in promoting knowledge, changing attitudes, developing intention to act, and gaining action skills. A "best practice" will involve as many of the four components as possible and will be achievable within the structure of school education.

Knowledge Change

The best predictor of the knowledge outcome of any EE practice is prior knowledge. People who start a program with high knowledge have less to gain from it, but they may also have the strong cognitive scaffolding upon which to build new learning (constructivist viewpoint, as in Dewey, 1938; Driver, 1984). Therefore a first step in determining success of a practice is to assess where the participants began. We have numerous examples of ways to do this, and baseline numbers to indicate starting points. For example, 5th and 9th grade students can answer about 38% and 48%, respectively, of knowledge questions about interdisciplinary topics of the oceans and Great Lakes (Fortner and Mayer, 1991). Their teachers report knowing enough about key aquatic topics to teach them adequately, but many topics are not taught because they are not seen as a priority or do not have a perceived place in the curriculum (Beiswenger, et al, 1991; Fortner and Meyer, 2000; Fortner and Corney, in review). Beiswenger's article actually identified "recreation" as the 2nd highest topic for teachers' water knowledge in Wyoming, and it ranked 4th as a teaching priority, with 50% of the respondents reporting it as either "high priority (frequently or always used in the curriculum)" or "use in curriculum varies with situation." Recreation was not included in the Fortner surveys of science teachers.

In various literature reports of specific projects, there are examples of students' knowledge being increased by (or related to) the following educational opportunities:

- In-service education of their teachers over an extended period (Fortner, Corney and Mayer, in review, Supovitz and Turner, 2000; Paul and Volk, 2000; MacGilchrist, 1996).
- Innovative infusion materials in locally relevant science (Fortner et al, in review).
- *Naturescope* magazines used in class (Armstrong and Impara, 1991).
- Specific emphasis on a topic in instruction (Birch and Schwab, 1983).
- Material certain to be tested.
- Watching an environmental documentary on television (Fortner and Lyon, 1985).
- Reading *National Geographic* and *National Wildlife* magazines (Fortner and Mayer, 1991).
- Pre-trip instruction about a natural site, by a visiting scientist (Lahm and Fortner 1986).
- Instruction in the field: resident and extended programs (Lisowski and Disinger, 1991; Jordan, et al, 1987; numerous dissertations 1970-85).

The knowledge of teachers about environment and about ways to teach it has been the subject of many reports. The most comprehensive ones in terms of geographic scope have dealt with how teachers use nationally disseminated infusion materials such as Project WILD and how teacher education mandates have worked in Wisconsin (Lane, et al, 1996). In the former study, nearly 90% of teachers reported using at least one WILD activity within a year of training. There is no indication that the teachers went beyond the materials used in their training workshop, either to learn more or to teach more about the environment. (Heimlich at Ohio State is conducting a new study of WILD impact in 2001.) In the Wisconsin study, authors followed up on elementary teachers who have been trained in environmental education since it was mandated by the state in 1985. After ten years, over half of the new teachers did not recall such training, and did not implement EE to a greater extent than teachers trained before 1985. They reported that they did not feel effective at infusing EE but personally know more and have more positive attitudes (Lane, et al, 1996).

Teacher knowledge and the impact of teacher education on classroom practice have been the subject of science education research as the National Science Foundation seeks evaluation of its state systemic initiatives. The kinds of teacher education programs that impact classrooms are those that have certain characteristics. According to Supovitz and Turner's (2000) synthesis of the literature, high quality professional development must:

- Immerse participants in inquiry, questioning, and experimentation and therefore model inquiry forms of teaching.
- Be both intensive and sustained.
- Engage teachers in concrete teaching tasks and be based on teachers' experiences with students
- Focus on subject-matter knowledge and deepen teachers' content skills.
- Show teachers how to connect their work to specific standards for student performance.
- Be connected to other aspects of school change.

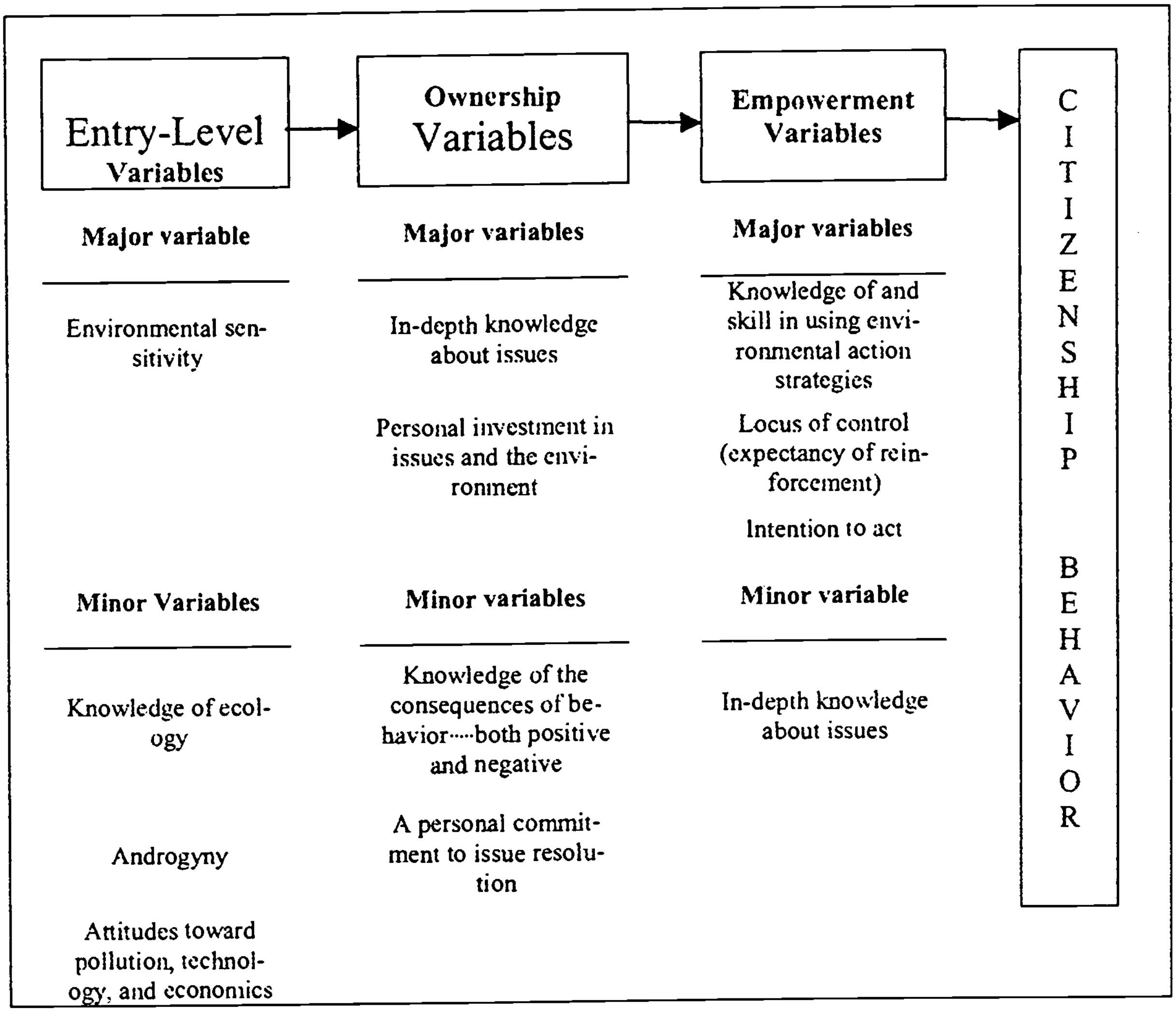
Such work is confirmed by programs in Ohio such as Kahle and Rogg (2000) and Fortner et al. (in review). All these works have emphasized that successful programs rely not only on teacher education but also on high quality curriculum materials.

Attitudes about the Environment

Newhouse (1990) defined environmental attitude as "an enduring positive or negative feeling about some person, object or issue." Attitudes are intimately associated with knowledge and often with behavior, but links among these attributes are inconsistent. We would like to think that teaching (providing information) about the environment or its issues would change people's attitudes about it so they would act on its behalf. In reality, the relationships are considerably more complex. Attitudes toward science and the environment are both generally positive among students, though most students report that even though these are important subject areas they are not very interested in them (Ma and Bateson, 1999).

The literature of EE reports that many kinds of experiences are capable of altering the attitudes people have about the environment. In one large study, a

Figure 2: Behavior flow chart: Major and minor variables involved in environmental citizenship behavior.

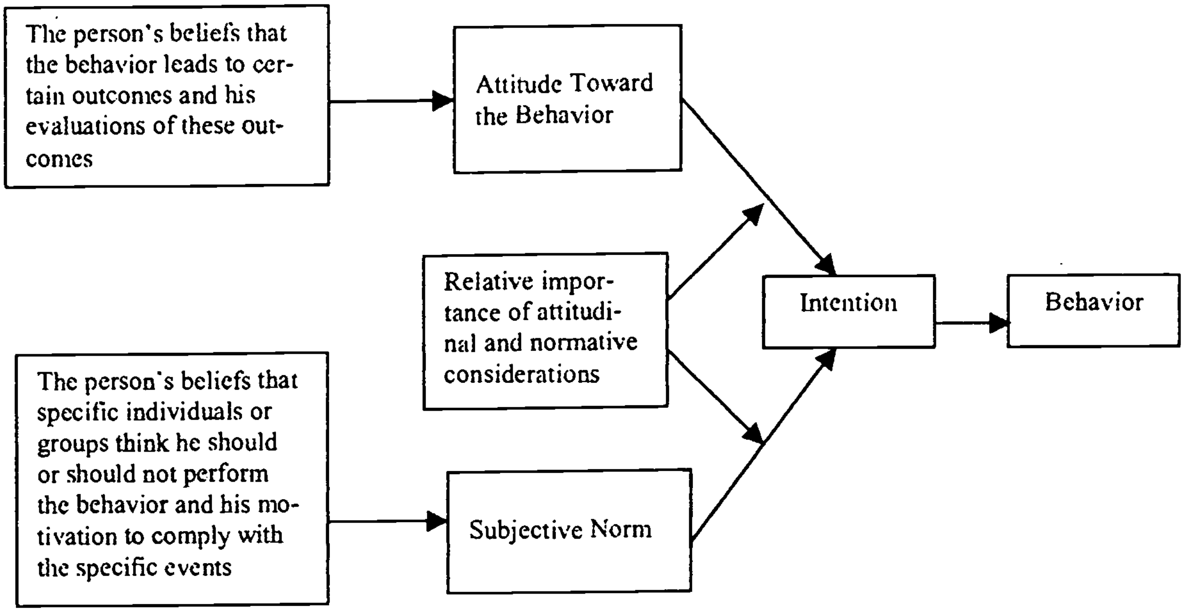


Source: Hungerford and Volk 1990.

multi-year program of teacher education about Issue Awareness and Investigation has been assessed by teacher follow-up (Paul and Volk 2000). The program has resulted in a high level of teacher use after extended training, and teachers report that there has been a positive response by parents and the communities in which the materials are used. Students in the teachers'classes register improved environmental attitudes. Other experiences that are related to positive changes in environmental attitudes include:

- Viewing a television documentary (though changes are short-lived) (Fortner and Lyon 1985).
- Media exposure in general (films, television especially) (Murphy, 1996).
- General positive attitude toward science (Ma and Bateson, 1999).
- Visit to a unique area, including a "fun" factor, with attitudes persisting for more than one year (Ryan, 1991).
- Frequent exposure to natural environments as part of school, family and other experiences (Chawla, 1999).
- Some teacher education programs (Lane, et al, 1996; Paul and Volk, 2000).
- Resident outdoor education programs (Dettmen-Easley and Pease, 1999; Zelezny, 1999; numerous others in 1970s and '80s).

Figure 3: Theory of Reasoned Action.



Source: Ajzen and Fishbein 1980.

Behavioral Intention and Skills for Action

The ultimate goal of environmental education is behavior change, and the strongest predictor of that appears to be "intention to act." A model has been developing at Southern Illinois University for many years based on EE literature alone (Hungerford and Volk, 1990), and it is widely accepted in the field. Based on this model (Figure 2), one might pursue the precursors of behavior with some assurance that the desired behavior would follow. EE needs to look beyond itself, however, because as a young research enterprise it could gain much from use of existing and well-established models such as the Theory of Reasoned Action (TORA) (Figure 3). This model from psychology includes the influence of the community within which the behavior will occur. and the norms of that group may actually be the strongest force acting on the behavior, regardless of instruction or other treatment.

An excellent meta-analysis of studies has been published by Zelezny (1999) to compare the effectiveness of various formal and non-formal EE treatments for "improving environmental behaviors." She found that classroom treatments were more effective than non-formal treatments, and those that used active involvement and/or younger participants were most effective. Unfortunately, much of the research she examined had methodological flaws, and most of the behavioral outcomes were self-report. Nevertheless, this is the best study we have to date combining diverse literature reports. The treatments noted in the effective research included:

- Instruction
- Issue investigation and action training
- Resident camp
- Weekend activities

Other literature has indicated that the following facilitate the development of "environmentally responsible behavior:

- Internal locus of control of reinforcement (Hines, et al, 1986-7).
- Opportunities to practice behavioral skills (Ramsey, 1993).
- Teachers or classes (Chawla, 1999).

Best practices for EE in Schools

Strong Science

To fit the first two components of EE's definition into the school curriculum is relatively simple because knowledge and awareness of interactions of the natural world are acknowledged outcomes of a good science program.

It is critical that EE be based on sound science, relying on genuine data collected in rigorous ways and without foregone conclusions. Critics of EE look for ways to challenge the science used to support environmental causes (e.g. Sanera and Shaw, 1996), and data that have an aroma of advocacy are prime suspects. EE must use science datasets that are above reproach in their source, collection methods and interpretation. Given that science is falsifiable, those who use data for EE must be open to reconsideration and alternative interpretations of their conclusions. For instruction, data should be introduced as the vehicle for decision-making: students should be taught to select and evaluate science methods to find those that provide a range of data for decisions, and information about the weight of evidence should always be available.

An example of how this works with ARE is found in the activity "Downeaster Alexa," part of the Earth Systems Education ACES book (*Activities for the Changing Earth System*, 1993). The activity deals with declining stocks of striped bass in the commercial fishery of Long Island Sound, and data from the National Marine Fisheries Service are the basis of the investigation into why fewer fish are being caught. Other data include thermal niche of the fish, reproductive potential, size of fish at catch, and impact of fishery closure in one state. All data sources are documented from credible sources. Data analysis alone points to overfishing and taking of progressively smaller fish. Recovery of the fishery after a period of closure adds weight to the conclusion. If changes in sea temperatures (global warming) are a factor, the data in 1993 were inconclusive. It is actually likely that <u>more</u> striped bass would find the region habitable under all the GCM scenarios, resulting in a greater catch rather than the observed decline.

Curriculum Access

If the topic is not in the school curriculum, getting it there could be a losing battle. Teachers are under serious pressure to be accountable: to meet the scope and sequence of topics that <u>are</u> their formal responsibility. The teachers who get the students next year depend on this as background, and proficiency test contents may also drive that required list. It is not a question of how valuable the topic is perceived to be.

The curriculum doors may open if the new topic can be used to teach an old standard one. Biology students must learn about food chains, for instance, and if a food chain relates to a walleye caught in Lake Erie (Fortner and Leach, 1979, 1997) then that can be the entry for some form of fishing education. Educators call this process "infusion," substituting non-textbook material as the method or vehicle for teaching a topic that is required in the existing curriculum. Frequently this is local information, a blending of materials, or a nontraditional format for learning that is seen as desirable.

ARE is not unique in looking to curriculum infusion for its entrée to schools. In fact, most schools that include environmental education do so on an infusion basis rather than a course that treats EE as a separate subject. Environmental educators see the value in such an approach but also the hazards. Infusion depends on good quality materials and teachers well trained to use them. EE can get into any subject area this way, but teachers must be convinced one-on-one that their subject matter is not being eroded. Infusion success is very difficult to evaluate because it is diffuse and individualized, and it may disappear when additional curriculum pressures appear.

Interdisciplinary

EE is not "pure" science in terms of standard disciplines, so another best practice is <u>interdisciplinary</u> (Wade, 1996). To teach about the environment requires consideration of interactions of the atmosphere, hydrosphere, lithosphere and biosphere, with human activities included. New curriculum reforms allow for this, but teachers have difficulty instituting it because most were trained in specific standard disciplines. A good starting point for making science as interdisciplinary as it needs to be for EE is to have infusion of topics that cross disciplines.

The curriculum that could include much of the why and the stewardship for ARE would cross not only science disciplines but would blend them with social studies, math, perhaps even the arts and literature. (Think "Big Two-Hearted River," "A River Runs Through It," and "Paddle to the Sea.") The Downeaster Alexa activity previously described is based on a Billy Joel song by that name, in which he describes the declining fishery in terms of its impact on the life of a bayman. From the song we learn about the alternative species, depth of fishing required, distances offshore for successful catch, the heritage of fishing, and the impact of the lost income on the fisher's family.

Active, Cooperative Learning

"Hands-on" has been an expectation of high quality education for decades, and the current term in use reaches further to "Hands-on, minds-on." The change stresses that activity for activity's sake is not the goal, but use of active learning for engaging the mind on a task is the desired outcome. To look at a classroom doing good EE would bring an image of students in small groups talking seriously with each other as they conduct their investigations. They have data, implements, maps, web sites and plans for answering an important question. They are using more than one scientific method--the controlled experiment has limited use in EE but more often the investigation is based on historical or observational data. The shift is from things that happen "here in the lab, right now" to "out in the world over a long time." They are examining the factors that inhibit salmon (or butterfly) migration, modeling insects (tying flies?) that survive or are eaten by predators, simulating the impact of a dam on wildlife in and around a river. While one group does a lab component, another constructs a questionnaire to ask parents about an issue, and a third group is gathering updated information from key web sites. When they pool their information, they have a greater chance at making informed decisions in answer to questions.

The cooperative/collaborative learning is an important aspect to best practice as well. For far too long we have been rearing students as competitors for grades. Instead many educators are shifting to the mode of cooperation toward learning goals for at least a portion of their class time. It is critical to show students by example that interdependence is the way the world really works: between people, between the environment and people, and within the natural environment. If no other attitude shift occurs in EE but this one, we will have been successful.

Extending Classroom Learning Beyond the School

"Service learning" gained attention in the late 1990s as a legitimate component of classroom education. This is a humanistic concept that comes and goes in the curriculum, so the realistic viewpoint is that its presence at a given time may relate to community or national politics. Obviously this is the kind of school activity that could greatly enhance the behavioral commitment goal for EE and the stewardship aspects of ARE. The first step is to develop decision-making skills to assist in the decision about what should be done, and what are the direct and indirect consequences of each action (including no action). If students have a chance to practice the skills that can lead to environmental quality or protection, they gain confidence in using those skills for other instances. The most effective service learning projects for schools are those that share information with the community: storm drain stenciling, flyers about control of exotic species, posters for storefronts about how to recognize harmful situations, etc. The school is a place for learning, and when the school reaches out, others should learn too.

Field studies are another obvious component of EE. While they are not as available in schools as in nonformal settings, a determined teacher will attempt to get students into the environment for studies. School groups that use their own outdoor areas or that visit field facilities such as Ohio State's Stone Laboratory on Lake Erie, or community parks and zoos, report a gain in learning. (But the reader should recall that Zelezny found many inadequate research methods in these reports.) The "novel environment" effect (hype over a day "out of school") can be avoided if out-of-class activities occur often and spontaneously, if specific tasks are preassigned to be done in the field, or if the experience is designed to feed back into ongoing school programs.

Assessing Outcomes of EE in Schools

Assessment should be based on objectives, and must take into account what people already know and do. Thus two types of assessment should be considered: Should we do it, and (assuming we do it) did it work?

The first and most commonly overlooked step, is the needs assessment or baseline study to determine whether the new program is needed, what parts are already mastered, how acceptable the plan or model is, and what barriers to implementation exist. If the school is the place where the ARE/EE will happen, teachers must be queried about the plan. In the Earth Systems Education program we typically follow the Rakow (1983) model and modify the topics. We ask teachers, for each topic:

- How important is it that your students know about this?
- How much do *you* know about it?
- To what extent do you teach about the topic?

From those responses, we have the teachers identify which topics they WANT to know more about (no use to spend funds on in-service programs with no participants!), and why they are NOT teaching some topics (identifies topics that just don't fit the curriculum, and also points out need for materials in some cases) (Fortner and Corney, in review).

Why not assess STUDENT knowledge and needs? The literature of EE, especially in aquatic education, has enough information to demonstrate low levels of student information without attempting major studies to justify ARE (e.g. Brody, 1996). An interesting note is that children often combine all kinds of environmental issues in their cognitive structure, so that one "evil" causes many destructions, or one good behavior (typically recycling) can solve all problems (Gowda, et al, 1997). If a specific topic is intended for students, a brief pretest may illuminate misconceptions and lack of key information.

Figure 4: Sample rubric developed by an Earth Systems teacher for use in evaluating individual student research projects.

Research Time Utilization	The student needed continual reminders to get back to work. Work may be inappropriate to the project.	The student was usually on task, but needed an occasional reminder to get back to work. All work is appropriate.	The student was always on task and did not need reminders to get back to work.
Participation in Project	The student does not add an equitable amount of work to the project and does not meet all requirements for the length of presentation.	The student adds an equitable amount of work to the project, but may not meet all requirements for the length of the presentation.	The student adds an equitable amount of work to the project and meets all requirements for the length of the project.
Accuracy of Information During Presentation	The student's information was lacking in content and was not factually correct in many places. Information may not be pertinent to the presentation.	The student's information is for the most part factually correct. Information may not be pertinent to the presentation.	The student's information is factually correct and pertinent to the presentation.
Clarity of Presentation	The student's work is not well planned. The student was confused by much of the information presented. The student was not clear in explaining topics.	The student's work is well planned. There seemed to be some confusion or misinterpretation of information.	The student's work is well planned and clearly explained. The student showed a clear command of the information presented.
Visual Aid Worksheet, or Simple Demonstration	The device used by the student was not used at a timely place in the presentation, had little bearing on the presentation, or was absent from the presentation.	The device used by the student was appropriate for the presentation. It may have been used in a more appropriate manner. The design of the device may not have maximized learning.	The use of the device was timely and appropriate. The design of the device was constructed to maximize learning.

Source: Mayer and Fortner 1995.

Outcomes Assessment

The evaluation technique should be in the same format as the treatment, so giving a multiple choice after a cooperative learning exercise is inappropriate. In fact, the most appropriate techniques for evaluation of EE are the ones considered "alternatives" to testing. We use rubrics if we are disposed to assign numbers to levels of attainment (Figure 4), and these are based on clear goals in various aspects of the learning. Typically the numbers indicate the relative value placed on different tasks within a project. For example, if data use is the main purpose of an investigation, data points might equal 30 of 50, while communication/interpretation skills rate 10 and group interaction 10. A new rubric should be constructed for each project type. Simpler rubrics list only the total points per component, while others break down intermediate steps toward excellence.

Portfolios and journals are valuable grading tools that give insight into student growth in thinking and skill development. Journals can be based on the student's ongoing work that leads to a project (a researcher's professional diary of sorts), or on her/his thinking and pursuit of information about a subject area. A journal is a work in progress. In rare cases a journal is more personal, with reflections on nature or critical thinking about a class process. This type of journal may be reviewed but not graded; suggestions from the teacher are acceptable. Portfolios are collections of student work, with pieces typically "finished" when they were added but leading toward an increased proficiency (e.g., writings and revisions). A portfolio should be able to demonstrate to parents what kinds/qualities of student work are valued. In the cases of journals and portfolios, attention to the contents and quality of work demonstrated are the basis for evaluation

Projects are the most common forms of outcome for cooperative learning, and the communication skills for the projects are valued along with the science. The format may vary widely -- a display, a videotape simulating a news broadcast, a group presentation with Powerpoint, a lesson for a younger group of students, or other medium prescribed by the teacher or selected by the students. Projects encourage cooperation, working toward a goal, and the importance of clarity of results. Students may be required to defend the information they are presenting as well. Projects are best evaluated with a rubric.

Some educators are concerned that since grades have to be assigned, and evaluation is so flexible, *all* students may be able to excel on the kinds of assessments listed. Environmental educators would respond that such an outcome would be wonderful! If EE is a community of scholars, acceptance of the work of others is appropriate, provided it meets community standards.

The question that was really answered: How can aquatic resource education succeed in the classroom?

According to theory and practice, environmental education topics that are appropriate to the curriculum can be infused if they are acceptable to teachers. The best EE is interdisciplinary, uses strong science, is implemented using active, cooperative learning, and is extended through service learning or field activities. Getting ARE into schools through EE can be accomplished by meeting teachers' needs for topics, having excellent curriculum materials, and delivering them through a strong program of teacher education. A model for this process from the Ohio Sea Grant Education Program is in Mayer and Fortner (1993): "A model for research and development interaction."

Recommendations for Research

There is a very large body of EE literature on the relationships between knowledge, attitudes and behavior toward the environment, but unfortunately much of the early years (through the '80s) were navel-study with bases only in other EE studies. In general our field could be enhanced and propelled forward by inclusion of the literature from older and more philosophy/psychology-grounded fields. In addition to that general upgrade in future research, some of the needs for this study are:

1) Methods for relating actual behavior to self-report (predictors of accurate reporting).
2) Follow-up studies for several years after participation in service learning.
3) Thorough scope of ARE, compared to matching points in existing school curricula.
4) Replication of Chawla (1999) using avid fishers/boaters as subjects (rather than activists).

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